Part Summary of the Project 'Speakers' Comfort': Teachers' Voice use in Teaching Environments

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ABSTRACT

Classroom acoustics not always take the speaker's comfort into consideration. The purpose of the presented papers was to investigate voice use, vocal behavior and prevalence of voice problems in Swedish teaching staff. Ratings of features in the work-environment on voice use were explored in $n = 487$ teachers. Based on their answers the respondents were split into two groups: teachers with self-assessed voice problems and voice-healthy teachers. Teachers with voice problems and were matched to a voice-healthy colleague from the same school and were investigated and compared for clinical findings and for vocal behavior. Acoustic properties of their teaching environments were measured. Teachers with voice-problems were more affected by any loading factor in the work-environment and were more aware of the room acoustics. Differences between the groups were found during field-measurements, while there were no differences in the findings from the clinical examinations of the larynx and voice. Voice problems seem to emerge in the interplay with and use of the classroom acoustics.

1. INTRODUCTION

During the last decades, there has been an increasing media focus on the non-optimal sound environment in schools. However, the focus has mostly been on the listeners and the sound environment in general, but not so much on teachers' voice use and the consequences of vocal problems. Nevertheless, research in the area of occupational voice problems and Voice Ergonomics has gained increasingly more interest and especially in teachers[1]. In 1996, Fritzell[2] presented an analysis of voice and occupations, identifying teachers to be the most common occupational group at voice clinics, the percentage of which largely exceeded the total percentage of teachers in the population at that time in

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Sweden[2]. The prevalence of voice problems in Swedish teachers is unknown although empirical knowledge shows that most teachers have experienced voice problems at some point during the work career. However, voice difficulties at work seem to be regarded as more of an individual problem, depending on the individual's innate capacities or voice use or "abuse", than as an occupational hazard[3]. Vilkman[3] summarizing relevant studies that have investigated subjective complaints among teachers, concluded that the majority of teachers have experienced vocal problems and 5% suffer from problems so severe that their working ability is questionable[3]. In their review, Verdolini & Ramig[4], estimated the costs for sick-days and treatment in US teachers to $2.5 billion[4]. Teachers have reported that their work performance is affected by their voice capacity and vocal problems e. g.[5, 6] and there are findings indicating that the students' understanding is hampered by a teacher's hoarse (dysphonic) voice[7–9]. However, even though much today is known about teachers' voices, voice use and prevalence of voice disorders, only a few studies have taken into account the teachers' opinion of their work-environment. Up to recently, even fewer have explored the teachers' actions in the work environment. Moreover, the work environment, *i.e.* the classroom's air-quality and acoustics, has often been discussed and acknowledged to contribute to the vocal load, but these factors are seldom investigated where and when the teacher is teaching. However, in recent papers, Rantala and colleagues[10,11] found a close connection between the number of voice ergonomic risk factors in the classroom and the amount of symptoms of voice problems in the teacher[10,11] whereas Cantor-Cutiva and colleagues[12] found the relationship between objective assessments of classroom settings and self-reports on physical symptoms to be less reliable[12].

The present paper is a summary of the voice part of the project 'Speakers' comfort and voice disorders in classrooms[13]. Three papers and material from two PhD theses are included in the summary[14,15,16,17,18]. The project investigated teachers' voice use in relation to the class-room acoustics, based on the hypothesis that the environment influences the way speakers regulate their voices. This is a perspective that has received scant attention in relation to teachers' voice health. The main purpose of the project was thus, to investigate the voices and the voice use of teaching staff in their teaching environment. A second aim was to explore the prevalence of voice problems in Swedish teachers and to investigate the teachers' assessment of aspects of the work-environment. ***Study I*** explored the prevalence of voice problems in teaching staff and to investigate their ratings of their voice and teaching environment[14]. The follow-up ***Study II***, examined the etiology of voice problems in teachers by exploring possible differences between 31 teachers with voice problems and 31 age and gender matched voice healthy colleagues from the same schools 15. All were recruited among the population of teachers from study I[14]. ***Study III*** was a field study, including 14 of the 31 pairs from *Study II*. This study more closely investigated the vocal behaviour and voice use in teachers with self-estimated voice problems and their age-, gender and school matched colleagues without voice problems, using matched pairs[16]. The main hypothesis of the project was that teachers with and without voice problems act differently with respect to classroom acoustics and air-quality, and that the vocal doses obtained with a voice accumulator would separate the groups. The details on the room acoustics and the measurement of the voice support are described by Pelegrín-García[17] and the measurements of the teachers' voices and vocal behavior are provided by Lyberg-Åhlander[18].

2. METHOD

For ***Study I*** a questionnaire was developed to assess teachers' ratings of their working environment and also to estimate the prevalence of voice problems in teachers. The questionnaire covered fifty-two items in three main domains: 1) background information; 2) room acoustics, perception of noise sources and other issues related to the environment and 3) voice problems, vocal behaviour and statements about skills in voice use. Two statements were considered to be index-statements: #1:" The classroom acoustics help me talk comfortably" and #32:" I have voice problems". The questionnaire was distributed to all teachers attending the collegual meetings at 22 randomly selected schools in the south of Sweden. It was completed anonymously by n=487 responders, corresponding to 73% of all teachers at the included schools. After exclusion due to incomplete questionnaires, data from a total of 467 responders (336F:131M, median age 47, range: 23–69) were finally evaluated. Teaching staff at all levels were included, except pre-school teachers at pre-schools and day-care-centres and teachers at specialised, vocational high schools, due to the large variety of teaching premises. Based on the ratings of statement #32 "I have voice problems", the participants were divided into two groups. *Group VP*, (N = 60) consisted of teachers suffering from voice problems (VP) sometimes, often, or always. *Group VH* (N = 407) included teachers having rated never or only occasionally experiencing voice problems (Voice Healthy, VH). There were no significant differences between the groups for gender (*Group VP* 80% F/20% M, *Group VH* 71% F/29% M), age (*Group VP* Md = 49.5, *Group VH* Md = 46), smoking (*Group VP* 10%, *Group VH* 7%), or years of occupation (*Group VP* Md = 20, *Group VH* Md = 16) as shown by a $\chi^2 2$ test[14].

For ***Study II*** two paired groups of teachers were formed: *Group VP* (N = 31, 26F/5M) included VP teachers with a median age 51 years (range 24-65) and a median time in occupation of 15 years (range 1–40); *Group VH* (N = 31, 26F/5M) included VH teachers with a median age of 43 years (range 28-61) and median time in occupation of 14 years (range 2–39). The pairs came from 12 of the 22 schools in study I[14]. The teachers underwent examination of the larynx and vocal folds with a 70 degree rigid laryngoscope. A digital recording system was used for laryngeal digital imaging, HRES Endocam, model 5562.9 color, Wolf, Germany. The teachers were recorded both in high resolution mode and high-speed mode (2000 frames/s for male and 4000 frames/s for female subjects). These recordings were used to evaluate mode and symmetry of glottal vibrations. A recording of a read text was used for perceptual and acoustic analysis of the voice. In addition, a standard Voice Range Profile was used to examine the range of intensities and frequencies that a participant could produce. The subjects also completed a battery of self-assessments, for psychosocial aspects; psychological health; personality; complementary questions on voice and teaching[15].

Study III. The field study examined how the classroom acoustics interacts with the voices of 14 teachers without voice problems and 14 teachers with voice problems, all recruited from Study II. The teachers in each pair (one teacher with voice problems and one voice healthy colleague) worked at the same school and were matched also for gender and age. All included teachers were non-smokers. As described above, the teachers had all undergone vocal assessments in Study II[15] and were without any major clinical remarks concerning the function of the vocal cords and larynx. The pairs

formed two equal groups: *Group VP*: teachers with self-assessed VP (n = 14, 12F:2M median age: 41, range: 24–62, md years in occupation = 13, range 2–40), and *Group VH*: VH teachers (n = 14, 12F:2M median age: 43, range: 28–57, md years in occupation = 18, range 2–28). The teachers kept a structured logbook during the workday and were registered with the Ambulatory Phonation Monitor 3200 vers. 1.04 (APM)[19]. The APM uses an accelerometer to calculate the movements of the vocal folds, through measurements of the skin vibrations of the neck that occurs during phonation. Based on the vibrations, the phonation duration (% of total registered time), fundamental frequency (in Hz), sound pressure level (in dB), and vocal doses are calculated. The APM does not record ambient noise, nor the spoken message. During teaching, the noise and voice levels at the teacher's position were measured with a sound level meter Svantek, mod. SV-102. The signals were picked up by a lapel microphone at a distance of 15 cm from the teacher's mouth. The teacher's voice level and the activity noise level were separated using mixed Gaussians. In addition, the background noise level and objective acoustic parameters of *Reverberation Time, Speech Transmission Index, sound strength* and voice support[20] were measured in the 30 empty classrooms of the study. A head and torso simulator (Brüel&Kjaer HATS mod. 4128) was used for the *voice support* measurements, whereas an omnidirectional loudspeaker (Brüel&Kjaer mod. 4295) and two omnidirectional microphones (Brüel&Kjaer mod. 4192) were used for measuring the other room acoustic parameters[21]. These microphones were also used for the measurement of the background noise level. The air humidity, room temperature, and the carbon dioxide (CO2) contents of the air were simultaneously measured during the work-hours with an indoor air quality measuring device[16].

3. RESULTS

3.1. Prevalence of voice problems and ratings of environment (Study I)

Based on the index question 'I have problems with my voice' the point prevalence of voice problems in Swedish teaching staff was estimated to 13%. There was a significant difference between the groups VP and VH for the index statement 'the classroom acoustics help me talking comfortably', Mann-Whitney U-test: (z = –3, 319) p = 0.001. Within the whole group, 38% disagreed that the class room acoustics helps the teacher to talk comfortably, among these 38%, 60% consisted of teachers within the VP group. There were significant differences between the groups for several of the items, (Mann-Whitney U-test), Table 1. The VP teachers rated items on room acoustics and work environment as being more noticeable. Within the total group, 92% of the teachers agreed on the presence of noticeable noise from the pupils. Also, the perception of disturbance from other noise sources, such as ventilation noise, noise from technical equipment, and noise from outside the classroom received a moderate to strong agreement by the entire group, but with no statistical differences between the two groups. Figures 1 and 2 show ratings in the whole group of some of the main items.

Moreover, the differences between the groups were significant for all statements within the voice section, Table 2. Absence from work because of voice problems was significantly more common in the group with voice problems: 35% versus 9% in the group without problems, χ^2 ($p<0.05$).

Table 1: Distribution of the ratings in percent, of statements on acoustics and environment for Group VP (*N* = 60), teachers with voice problems and Group VH (*N* = 407) teachers without voice problems. (Grades: 0 = completely disagrees-4 = agrees completely). The *z* and *p* values for the Mann-Whitney test comparing the groups are also provided

Acoustical and environmental statements	*N*	0 (%)	1 (%)	2 (%)	3 (%)	4 (%)	*z*	*p*
1. The class-room acoustics help me talk comfortably								
Group VP	60	25	30	33	7	7	–	
Group VH	402	11	25	39	18	7	–3.319	0.001
2. There is an echo in the class-room.								
Group VP	59	29	29	20	17	5	–	
Group VH	403	36	28	23	10	3	–1.489	0.137
3. The class-room is difficult to talk in.								
Group VP	60	10	19	39	25	7	–	
Group VH	407	23	29	29	16	3	–3.521	0.000
4. I need to increase the power of my voice to make myself heard even with just a little noise in the class-room								
Group VP	60	5	14	25	37	19	–	
Group VH	407	17	28	27	20	8	–4.595	0.001
5. The class-room air feels dry.								
Group VP	60	7	17	20	26	30		
Group VH	407	17	18	28	24	12	–3.377	0.001
6. My voice gets muffled by the class-room acoustics.								
Group VP	58	9	14	46	26	5	–	
Group VH	404	19	23	35	21	2	–2.584	0.010
7. There is a draught in the class-room even when the door is closed.								
Group VP	60	23	22	15	27	13	–	0.002
Group VH	404	40	25	13	13	9	–3.114	

(Continued)

Acoustical and environmental statements	*N*	0 (%)	1 (%)	2 (%)	3 (%)	4 (%)	*z*	*p*
8. The noise made by the pupils is very noticeable in the class-room.								
Group VP	59	5	12	19	34	30	–	
Group VH	405	8	14	25	28	25	–1.602	0.109
9. The noise from the ventilation is noticeable.								
Group VP	60	12	29	22	17	20	–	
Group VH	404	24	24	20	20	12	–1.903	0.057
10. The noise from audio/visual resources is noticeable.								
Group VP	60	35	19	21	15	10	–	
Group VH	404	37	27	17	11	8	–1.004	0.315
11. The noise coming from out-side of the class-room is noticeable.								
Group VP	60	17	18	30	23	12		
Group VH	405	19	24	24	22	11	–.883	0.377
12. I have problems with my hearing								
Group VP	59	37	18	17	14	14		
Group VH	406	37	21	15	13	13	–.012	0.990
13. The class-room acoustics has influence on my way of talking (with the pupils present).								
Group VP	58	21	8	14	29	28	–	
Group VH	406	28	16	26	18	12	–3.278	0.001

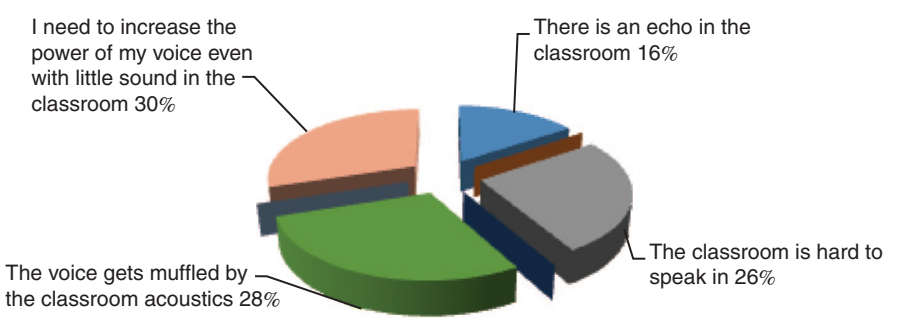

Figure 1. Perception of voice use in relation to the classroom acoustics in % of the total $n = 476$ teachers.

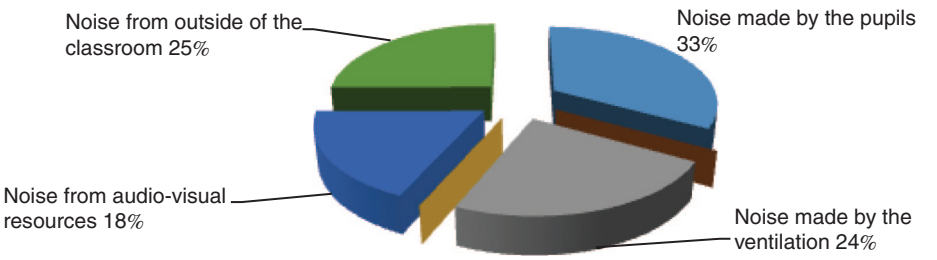

Figure 2. Perceived main sources of background noise in % of the total ratings by

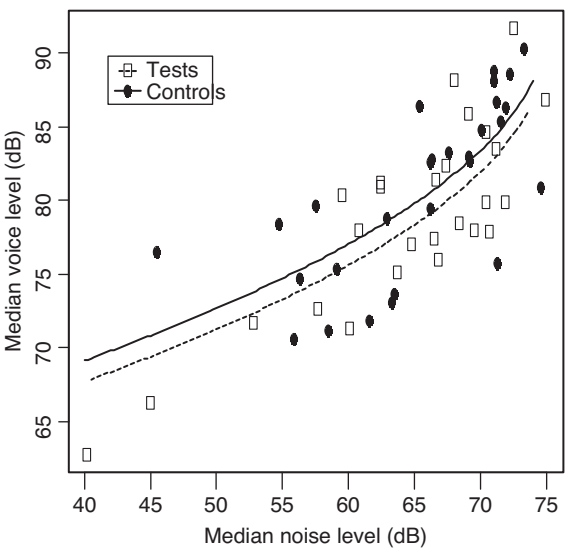

Figure 3. Median voice SPL used by teachers versus median activity noise SPL. As a consequence of the Lombard effect, the voice levels increase with the noise levels, equally for teachers with and without voice problems. However, teachers in the control group use higher voice levels than those in the test group[21]. Tests = teachers with voice problems, $n = 14$; Controls = vocally healthy teachers, $n = 14$.

3.2. Etiology of voice problems (Study II)

This study explored possible vocal, structural and psychological differences within pairs of teachers. Only small differences were found between the groups. Minor morphological abnormalities of the vocal folds were found in 13 subjects (5/31 in the VP Group 8/31 in the VH Group); some remarks on voice quality and hearing were made, and also some negative reports of psychosocial wellbeing but no findings reached statistical significance. Nor did the instrumental analyses of voice range and F_0

Table 2: Distribution of the ratings in percent, of statements on voice for Group VP (*N* = 60), teachers with voice problems and Group VH (*N* = 407) teachers without voice problems. (Grades: 0 = never, 1 = occasionally, 2 = sometimes, 3 = often, 4 = always). The *z* and *p* values for the Mann-Whitney U test comparing the groups are also provided

Voice statements	*N*	0 (%)	1 (%)	2 (%)	3 (%)	4 (%)	*z*	*p*
14. I need voice amplification								
Group VP	58	83	3	9	5	0		
Group VH	404	92	4	2	1	1	–2.410	0.016
15. I need to clear my throat								
Group VP	59	5	14	32	42	7		
Group VH	406	21	45	27	7	0	–7.824	0.000
16. My voice sounds hoarse								
Group VP	60	3	15	42	38	12		
Group VH	406	29	46	20	4	0	–8.771	0.000
17. My voice can suddenly change when I talk								
Group VP	59	15	24	35	24	2		
Group VH	407	40	39	18	2	0	–6.263	0.000
18. I need to strain to make my voice work								
Group VP	60	10	8	37	37	8		
Group VH	405	47	37	13	2	0	–9.475	0.000
19. My voice limits my work								
Group VP	59	15	25	36	20	4		
Group VH	406	64	28	6	2	0	–9.139	0.000
20. I avoid certain tasks due to my voice								
Group VP	60	43	25	17	8	7		
Group VH	407	83	14	1	0	0	–7.798	0.000
21. Due to my voice the pupils have trouble hearing me								
Group VP	60	35	40	20	5	0		
Group VH	406	79	18	3	0	0	–7.678	0.000
22. I have wanted to stay at home due to problems with my voice								
Group VP	60	47	23	27	3	0		
Group VH	407	83	14	3	0	0	–6.850	0.000

(Continued)

Voice statements	*N*	0 (%)	1 (%)	2 (%)	3 (%)	4 (%)	*z*	*p*
23. Others ask what is wrong with my voice								
Group VP	60	62	23	12	3	0		
Group VH	404	94	5	1	0	0	–8.151	0.000
24. I have stayed at home due to problems with my voice								
Group VP	60	65	22	12	2	0		
Group VH	407	85	12	2	0	0	–3.988	0.000
25. I have a sensation of discomfort in my throat								
Group VP	60	10	23	30	34	3		
Group VH	405	56	30	12	2	0	–9.110	0.000
26. My voice upsets me								
Group VP	60	8	27	43	14	8		
Group VH	407	83	14	3	0	0	–13.437	0.000
27. I run out of air when I talk								
Group VP	60	47	18	20	12			
Group VH	406	79	16	4	1	0	–6.064	0.000
28. My voice makes me feel incompetent								
Group VP	60	48	15	22	15	0		
Group VH	401	88	9	2	0	0	–8.360	0.000
29. My throat is burning								
Group VP	59	32	29	20	19	0		
Group VH	407	71	22	6	1	0	–6.847	0.000
30. It feels like a lump in my throat								
Group VP	60	37	25	23	12	3		
Group VH	407	72	20	6	2	0	–6.280	0.000
31. I have sensations of gastritis								
Group VP	60	50	20	20	8	2		
Group VH	407	72	14	9	4	1	–3.500	0.000
32. I have problems with my voice								
Group VP	60	0	0	75	22	3		
Group VH	407	72	28	0	0	0		

Table 3: Time for recovery from voice problems in two groups of teachers, teachers with voice problems (Group VP) and teachers without voice problems (Group VH), in percent

	No voice probl	One hr or less	A couple of hrs	Over night	Weekend	Holiday	Never	%
Group VP ($N = 31$)	0	13	10	27	23	17	10	100
Group VH ($N = 29$)	34	17	7	24	7	10	0	100

in running speech reveal any differences. The groups did differ for all questions of voice as shown by paired samples t-test and for time for recovery after voice problems: χ^2, $(7\ n = 60) = 17.608$, $p = 0.014$. The VP group rated significantly longer time needed for recovery, Table 3. Further, within the VP-group, 18% had considered change of work due to voice problems but none in the VH group, as shown by Fisher's exact test ($p = 0.029$).

3.3. Field study of voice use in relation to the work environment (Study III)

The teachers' voice use in the classrooms differed between the groups for a number of parameters. Teachers in the VP group used their voice differently from their VH peers, in particular during teaching sessions. The *time dose* (% of voicing) was significantly higher in the VP group, throughout the workday, as shown by a paired t-test ($p = 0.006$) and specifically for teaching ($p = 0.003$). The phonation time for teachers in this material varied between 17–24% with the VP group reaching the higher percentages. Also the F_0 pattern, related to both voice-SPL and the room acoustics differed between the groups. The VP did not raise their F0 with increasing the voice SPL, whereas the VH group raised the F0 with the SPL increase[16]. The VP group either kept the F_0 stable or decreased it. According to the Lombard sign, the common behavior of a speaker would be to raise the F_0 as the subglottal pressure increases to increase the vocal SPL[22]. Further, there was a difference between the groups as to the subjective assessments of vocal aspects during the day. The VP group with voice problems rated their voice problems during the day significantly worse than their colleagues: Mann-Whitney U-test ($p = 0.001$). The VP group also rated a number of voice related symptoms significantly higher (worse) than the VH-group: degree of vocal fatigue ($p = 0.001$), voice brake or voice change during speech ($p = 0.02$), throat clearing ($p = 0.02$), coughing ($p = 0.02$), throat ace ($p = 0.003$), throat tenseness ($p = 0.001$) and air loss during speech ($p = 0.002$). An empirical model shows that the measured voice levels depend on the activity noise levels and the Acoustical *Voice Support*, ST_V (see Fig. 3-5)[20, 21, 23]. Take into account that the empirical model considers together the noise and ST_V, and therefore the goodness of fit for the model of 2 variables is R^2 = 0.69, F_4,49 = 27.8, $p < 0.001$.

The voice support is calculated as follows:

$$ST_V = 10 \log \frac{E_r}{E_d}$$

where E_r and E_d are the direct and reflected sound levels at the speakers ear.

In relation to the ST_V, the vocal behavior of the two groups showed opposite trends, Figure 4. The VP group decreased the SPL of the voice with increasing *Voice Support* in the classrooms. There were no significant differences between the teaching environments for the VP and VH groups for any of the parameters, ST_V, STI, or RT, shown by independent samples *t* tests: ST_V: $t(23) = -0.86$, $P = 0.399$; STI: $t(23) = 0.21$, $P = 0.834$; RT: $t(23) = -1.36$, $P = 0.187$. Nor were there any significant differences between the measured rooms with regard to ambient air quality, temperature and humidity although with temperatures ranging from 17.3°–25.1°C. The present measurements were made during the winter, which means that the temperature was regulated by indoor heating. The mean CO_2 levels were below the Swedish regulation for indoor work, 1000 ppm (AFS, 2009:02)[24], but, in a few rooms the CO_2 level exceeded the stipulated maximum value. The mean humidity estimate was low, 26%, which is normal during the winter in Sweden (AFS, 2009:02)[24].

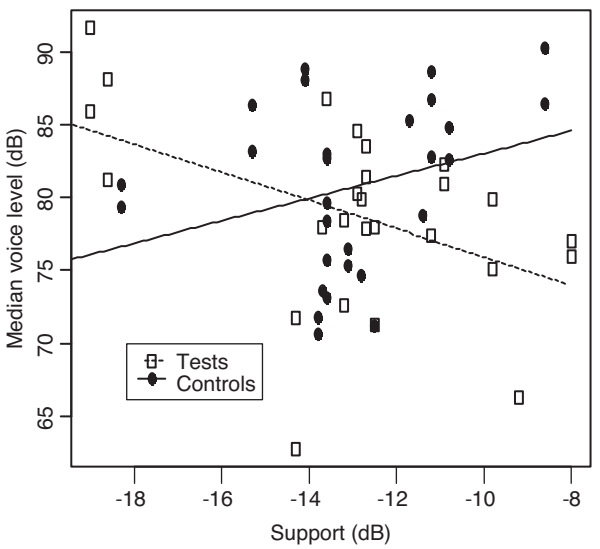

Figure 4. Median voice SPL used by teachers versus voice support measured in the empty classrooms. The two teacher groups make use of the voice support in significantly different ways[21]. Tests = teachers with voice problems, $n = 14$; Controls = vocally healthy teachers, $n = 14$.

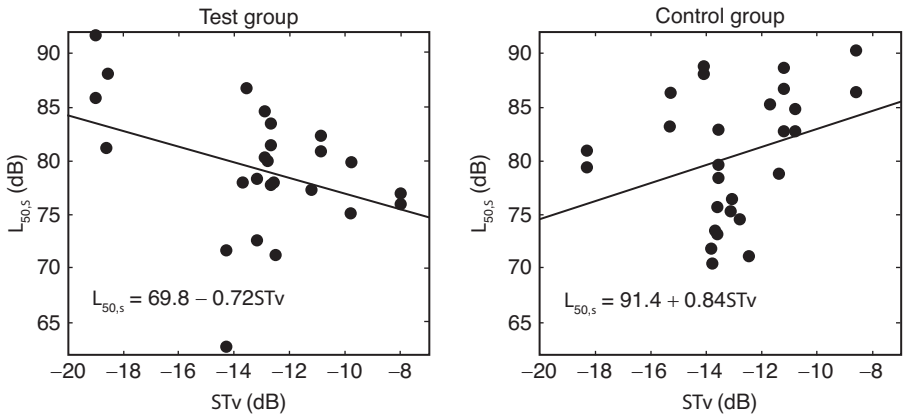

Figure 5. Median Voice SPL dB in relation to room-support in the group with voice problems (left) and their voice healthy colleagues (right).

4. DISCUSSION

This project corroborates the hypothesis that teachers often suffer from voice problems due to work-related factors. The point prevalence of voice problems in Swedish teaching staff was estimated to 13% which is in line with earlier research from a range of countries[5,6,25]. The results indicate that teachers suffering from voice problems react stronger to vocally loading factors in the teaching environment, report more frequent symptoms of vocal discomfort and, are more often absent from work due to voice problems compared to their voice-healthy colleagues. The environmental factors assessed as negatively affecting the vocal load are related to the voice use, background noise, room acoustics, air quality, stress and psychological factors and in the lack of time for voice rest and recovery. These results are corroborated by findings in recent studies, investigating environmental risk factors for voice use[10,11]. Although several room parameters were found to influence the voice use we did not find any measurable differences between the rooms of the groups for temperature, ambient air quality or over-all room acoustics. This might seem counter intuitive, but it is important to underline the complexity of voice and voice problems and the interplay between individual and external factors. At a group level, the teachers' voice problems were most clearly seen in the interaction with the environment, since no significant differences were found between the groups for structural, vocal or psychological factors. Hence, an intriguing finding is the result of the groups' different use of the room acoustics. Although all teachers aligned with the increased back ground noise according to the Lombard effect[22] (Fig. 3) the teachers with voice problems seemed to be more aware of the classroom's acoustic conditions than their healthy colleagues, as shown in Fig. 4 and in detail in Fig. 5 where the groups are presented separately. The teachers with voice problems (Fig. 5 left-hand panel) seemed to make use of the more supportive rooms to lower their voice levels and thus

decrease their *vocal effort* to increase the *vocal comfort* (defined as the speaker's perception of being heard in a room, with little or no vocal effort[26]). As later discussed by Pelegrín-García et al (2014) teachers having voice problems also preferred longer decay times[23]. As shown in Fig. 5, right panel the voice healthy group did not seem to rely on the room acoustics in the same manner as the group with voice problems. More research is needed and we can as for now only speculate about the underlying causes of this discrepancy between the groups. In the questionnaire study[15] the teachers with voice problems to a larger extent than the voice healthy colleagues expressed that they experienced that they had difficulties in making themselves heard and that they had to strain the voice to make themselves heard even with only little back-ground noise. The increased use of the room acoustics could mirror that the teachers in the VP group tries to find support for their voice use. Although not statistically significant, the teachers with voice problems spoke 1.14 dB softer than their voice healthy peers which also gives support to the need of the teachers with voice problems to seek amplification and support to their voice. The knowledge of the effect of the room acoustics for the talker is of great importance when designing teaching environments and not least when helping a voice-fatigued teacher to use the voice in an effective manner. Some additional factors are important to consider when describing the speaker's vocal behavior and comfort in a room: the distance between the talker and the listener must be considered and properties of the room influencing the auditory feedback of the room and the subjects hearing, influencing the acoustic feedback of the talker's own voice. Hence, even with cautious interpretation we would like to conclude that speakers with voice problems act differently with respect to the room acoustics and that they would benefit from being trained in using the room to support their voice. Traditionally, research and interventions concerning classroom acoustics have been directed to the listener's perspective and the speech intelligibility of the room. The speaker's voice use and vocal comfort have rarely been considered and should be taken into account when designing teaching and learning environments. Based on the findings of the project 'speakers' comfort'[13], Pelegrín-García and colleagues[23] recently presented guidelines for classroom acoustics design that meet simultaneously criteria of vocal comfort and speech intelligibility 23. For optimal acoustics including both the listener and the speaker both Speech Intelligibility and Vocal Comfort related to ST_V and reverberation times need to be taken into account. More research is warranted related to how teachers with and without voice problems act in varying room acoustical conditions. Moreover, today teachers are rarely trained in caring for and optimizing their voice and voice use. Nor are they trained in making use of the room and room acoustic premises as a pedagogic tool. This lack of training has negative consequences both for the teacher's health and well-being as well as for the communication with the students[7]. It is important to underline that the teachers with voice problems in this study are with some exceptions, not former or ongoing patients at voice clinics. The possibility to seek help for a dysfunctional voice is not well known, partly because competence on voice disorders is lacking in occupational health care teams as well as in the open health care sector.

4.1. Methodological considerations

There are some limitations in the studies to consider when interpreting the results. Firstly, the questionnaire in the prevalence study did not reach all teachers at the included schools. The teachers who were absent at the collegial meeting where the questionnaire was distributed were not reached. It's hardly possible to speculate but the missing teachers might have been staying at home due to voice problems. Further, we don't know if the long time measurements of voice affected the behavior of the teachers or, that of the students making them less noisy. Moreover, parts of the findings of a speaker's adjustment of their voice level under different classroom acoustics conditions were made in a laboratory setting[26] which may have impacted the results through lack of reality.

5. CONCLUSIONS

Teachers heavily depend on their voice use and voice problems are common. The point prevalence of voice problems of Swedish teaching staff was calculated to 13%. Teachers with and without voice problems identify vocally loading factors similarly, but the group with voice problems rates the negative influence higher and is more worried about their voice. Differences between voice healthy teachers and teachers with voice problems are found during field measurements and in relation to the use of the room acoustics. Awareness of the influence of the acoustic properties of the classroom is of great importance when designing teaching environments and in voice care for teachers. Field voice measurements should be included when exploring occupational voice problems since it is clear that it is in the interplay between the individual and the work environment that the voice problems emerge.

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